(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 050 984 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
08.11.2000 Bulletin 2000/45

(51) Int Cl.7: **H04H 1/00**

(21) Application number: **99109102.6**

(22) Date of filing: **07.05.1999**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(71) Applicant: **Sony International (Europe) GmbH**
10785 Berlin (DE)

(72) Inventors:
- **Merkle, Carsten, Sony Int. (Europe) GmbH**
70736 Fellbach (DE)
- **Wildhagen, Jens, Sony Int. (Europe) GmbH**
70736 Fellbach (DE)
- **Zumkeller, Markus , Sony Int. (Europe) GmbH**
70736 Fellbach (DE)

(74) Representative:
MÜLLER & HOFFMANN Patentanwälte
Innere Wiener Strasse 17
81667 München (DE)

(54) Alternative frequency strategy for DRM

(57) A radio transmission signal consisting of signal frames that comprise a dynamic data part and a quasi-static data part according to the present invention is characterized in that the dynamic data part of a respective frame contains an indicator showing in which following frame the quasi-static data part of this respective frame will be repeated. Therewith, an alternative frequency of e. g. a digital shortwave signal like a DRM signal can easily and satisfactorily be checked before a fast seamless switching to this alternative frequency can be performed. The inventive method to perform a seamless switching of a receiver from a first currently tuned frequency to a second alternative frequency is characterized by the step of receiving at least one set of samples from a respective signal transmitted on at least one second frequency during a time period during which said indicator assures that it is secure that only data that has been transmitted at least once is transmitted as signal on said first frequency to gather some information about said alternative frequency.

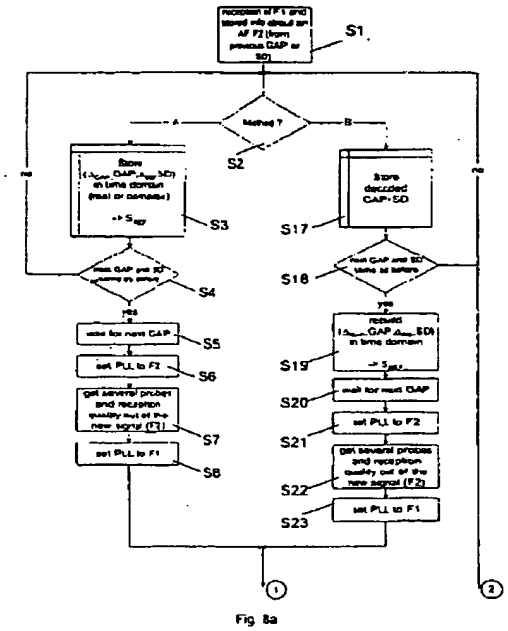

Fig. 8a

EP 1 050 984 A1

Printed by Jouve, 75001 PARIS (FR)

(Cont. next page)

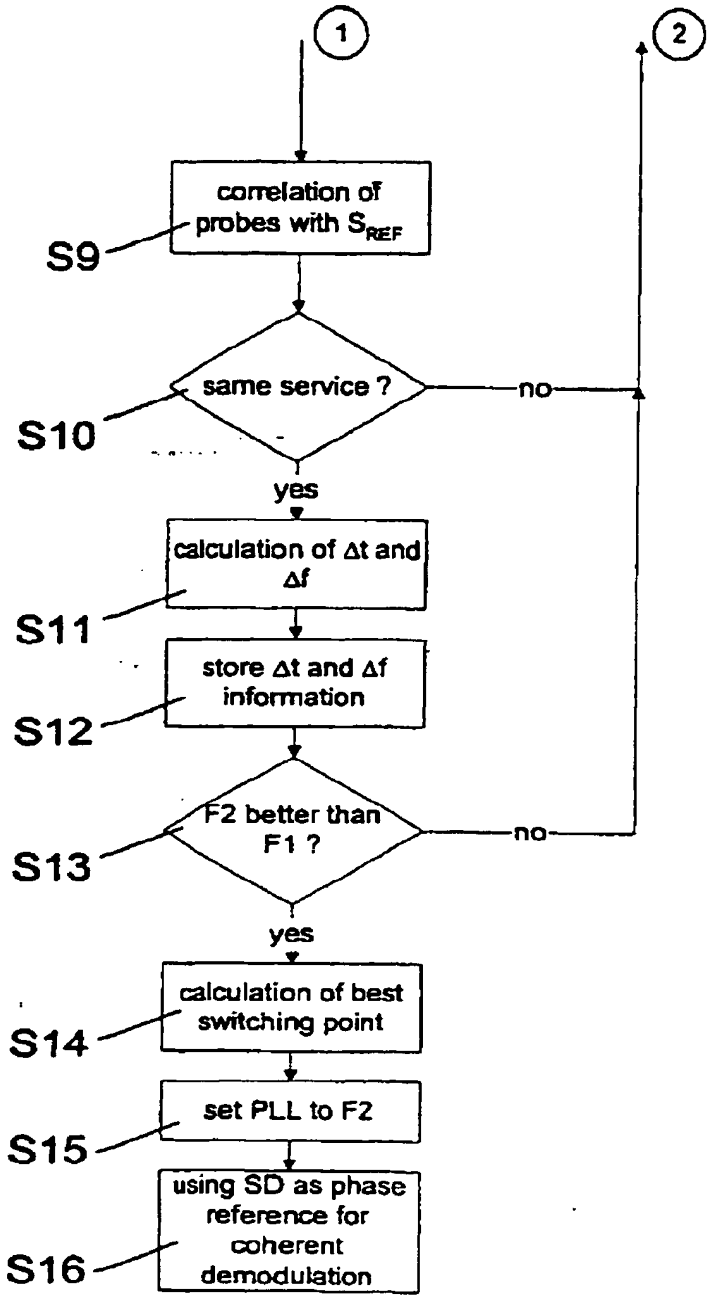

Fig. 8b

Description

[0001] The invention relates to a radio transmission signal consisting of signal frames that comprise a dynamic data part and a quasi-static data part as well as to a method to perform a seamless switching of a receiver for such radio transmission signals from a first currently tuned frequency to a second alternative frequency (AF).

[0002] In broadcast systems that deliver the same services in adjacent or overlapping areas on different frequencies, it is needed to find a proper criteria to switch to an alternative frequency without loosing the service, i. e. to perform a seamless switching.

[0003] In public information service systems like DAB or DVB-T techniques for switching to alternative frequency are used, but they provide no disturbance-free switching from one frequency to another. In the EP-A-98 119 400 a method and data frame structure for the digital transmission of information is suggested in which the transmission system is defined such that the receiver is able to test an alternative frequency without loosing any relevant information on the current tuned frequency, because the signal in the air consists of two parts, namely a continuous data-channel like audio with interleaving in time, but not repeated, and a static data channel including information about the service, multiplex configuration, program time, transmitter ID, service ID and alternative frequency list. In this system the receiver has the time to check alternative frequencies without loosing relevant information data during the static data-channel.

[0004] However, this transmission system underlies the condition that the static data-channel is identical and unique for all services at all times, i. e. the same static data-channel is transmitted by all transmitters belonging to a service without any changes at any time. For a certain radio transmission systems, e. g. DRM (Digital Radio Mondial), no such reliable static data-channel is provided and therefore it cannot be secured that in such radio transmission systems a seamless switching will be performed in any instance.

[0005] It is the object of the present invention to provide a disturbance-free switching between various transmitters delivering the same services in adjacent or overlapping areas on different frequencies also for radio transmission systems that do not provide a static data-channel, but only a quasi-static data-channel that comprises in general only static data, but allows also changes of this static data.

[0006] This object is solved on basis of a radio transmission signal consisting of signal frames that comprise a dynamic data part and a quasi-static data part as defined in independent claim 1 which is characterized in that the dynamic data part of a respective frame contains an indicator showing in which following frame the quasi-static data part of this respective frame will be repeated.

[0007] Preferred embodiments of such a radio transmission signal are defined in dependent claims 2 to 6.

[0008] Based on such a radio transmission signal a method to perform a seamless switching from a first currently tuned frequency to a second alternative frequency is defined in independent claim 7 by the step of receiving at least one set of samples from a respective signal transmitted on at least one second frequency during a time period during which said indicator assures that it is secure that only data that has been transmitted at least once is transmitted as signal on said first frequency.

[0009] Preferred embodiments of this method are defined in dependent claims 8 to 14.

[0010] A receiver according to the present invention is defined in claim 15. Preferred embodiments thereof are shown in dependent claims 16 to 19.

[0011] According to the present invention seamless switching between alternative frequencies is allowed without loosing any data, since it is secure to check different alternative frequencies or to switch to an alternative frequency without loosing any data during a repetitive part which is identified on basis of an indicator in the dynamic data part of a transmission signal. Preferably, a radio transmission signal according to the present invention consists of a quasi-static data-channel (SD), a dynamic data-channel (DD) and a gap-channel (GAP). The signal is then formed of consecutive frames each of which consists of a gap part, a quasi-static data part and a dynamic data part. In this case, a respective indicator within a respective dynamic data part about the quasi-static data part relates also to a forthcoming gap part transmitted in the same signal frame as the symbol(s) of the quasi-static data part the respective indicator relates to.

[0012] An advantageous structure within the dynamic data-channel is to provide said indicators together with a frame counter so that an easy indication in which following frame the same symbol(s) will be transmitted in the quasi-static data-channel and eventually the gap can easily be assured.

[0013] The content of the gap-channel and quasi-static data-channel is e. g. the alternative frequency list with geographical references and the multiplex information, information about the service, program type, transmitter ID and service ID which might change from time to time, e. g. in case a certain alternative frequency is switched to another service or the program type of a frequency changes.

[0014] The invention and the underlying concept will be described in the following with reference to the accompanying drawings, in which

- **Fig. 1** depicts the principle frame structure and partly the preferred contents of information units according to the invention;
- **Fig. 2** elucidates the basic frame structure of a signal with its delayed version on an alternative frequency;
- **Fig. 3** elucidates the basic frame structure of a sig-

nal with its early version on an alternative frequency;

Fig. 4 shows the correlation result of two probes of the signal transmitter on an alternative frequency with a reference signal generated within the receiver;

Fig. 5 explains the maximum delay of an alternative frequency in respect to a currently tuned frequency for the checking of the alternative frequency;

Fig. 6 explains the maximum delay of an alternative frequency in respect to a currently tuned frequency for the checking of the alternative frequency in case the gap part is used as synchronization symbol;

Fig. 7 explains the maximum delay for a seamless switching from a currently tuned frequency to an alternative frequency;

Fig. 8 depicts a flow chart for an alternative frequency switching in a receiver adapted to the method and for the radio transmission signal according to the invention; and

Fig. 9 is a block diagram of a receiver with features according to the invention.

[0015] A digital transmission system embodying the invention should have a frame structure as shown in Fig. 1. The signal in the air generally consists of two parts, i. e.

- a dynamic data-channel (DD) like an audio-channel with interleaving in time, but not repeated, and
- a quasi-static data-channel (SD), e. g. comprising the information about the respective service, i. e. multiplex location, program type, alternative frequency list, transmitter ID and as the case may be additional service information.

[0016] Additionally, a gap can be located within a frame, as also shown in Fig. 1, which could have a variable length depending on the transmission frequency and therefore on the possible delay between the alternative frequencies. For OFDM stystems the variable lenght of the gap might be realized by reducing the total amount of carries. This gap can either be empty or information transmitted within the quasi-static data-channel can be shifted to the gap.

[0017] The quasi-static data-channel and/or the gap might comprise a guardinterval.

[0018] According to the present invention, the respective dynamic parts of the dynamic data-channel comprise status information for the respective corresponding quasi-static data parts of the quasi-static data-channel or the quasi-static data-channel and the gap. This status information might show the frame number of the following frame in which the quasi-static data part and if applicable the gap part comprise the identical symbols as the quasi-static data part and if applicable the gap part of the frame comprising the status information. In an advantageous embodiment the dynamic data-channel carries also a frame counter in every dynamic data part indicating the respective frame number.

[0019] For the following description the assumption is made that a frame consists of a gap part GAP, a quasi-static data part SD comprising one symbol and a dynamic data part DD as shown in Fig. 1. Of cource, the order of SD and GAP can be changed. Furtheron, the status information should be valid for the symbols included within the static data part and within the gap part. Both, the gap part and the quasi-static data part comprise a guardinterval.

[0020] The quasi-static data part should preferably satisfy the following rules:

- The quasi-static data should be in general identical and unique for all services, reference carriers are allowed,
- data included in the gap should be in general identical and unique for all services,
- the quasi-static data provides a frequency synchronization possibility that must not necessarily be a phase reference symbol like transmitted in DAB,
- the frame counter and status information have to be outside the static data part and gap part.

[0021] As mentioned above, the repetitive part of the signal is the GAP and SD. On all frequencies of the same service the GAP and the SD are in general the same and unique for this service, i. e. no other service has the same GAP and SD. This might be supported by a specific scrambling of data.

[0022] During the time the repetitive part at the current frequency occurs, i. e. the status information for GAP and SD of an earlier frame indicated that the GAP and SD of the current frame has already been transmitted at least once, the receiver can check an alternative frequency. In the present case at least one set of samples, e. g. one spot of several samples, is taken from the alternative frequency as a signal probe and will be correlated with a reference signal within the receiver to gather some information about the alternative frequency. This reference signal might be simply a copy of a previously received GAP and SD in the time domain or can also be a rebuilt signal that is gathered from the information of one or more previously received GAPs and SDs.

[0023] On basis of the correlation peak(s) the receiver can decide if the alternative frequency comprises the same service and in addition the time synchronization can be calculated. If two spots of several samples are correlated, additionally a frequency synchronization, i. e. an estimation of Δf in-beetween the current frequency or nominal frequency and the alternative frequency can also be calculated.

[0024] At the next repetitive part the receiver is then able to switch to the alternative frequency before the SD-symbol occurs on the alternative frequency to use